

Application No. 10/692,125
Response to Office Action

Customer No. 01933

Listing of Claims:

1. (Currently Amended) A semiconductor light emitting device comprising:

a semiconductor substrate formed from InP;

an active layer which is formed from InGaAsP and provided at
5 the an upper side of the semiconductor substrate, and which has
a width of not less than 3.5 μ m; and

an n-type cladding layer formed from InGaAsP and a p-type cladding layer formed from InP, which ~~are formed so as to~~ hold the active layer therebetween,

10 wherein ~~, the semiconductor light emitting device is,~~ given that a refractive index of the n-type cladding layer is n_a , and a refractive index of the p-type cladding layer is n_b , ~~set so as to be the~~ a relationship of $n_a > n_b$ in which the refractive index n_a of the n-type cladding layer is higher than the refractive index
15 n_b of the p-type cladding layer is satisfied, and ~~due to the~~ wherein a distribution of light generated by the active layer being is deflected to the n-type cladding layer side, such that optical loss by intervalence band light absorption at the p-type cladding layer is suppressed, ~~, and high power light output can~~
20 ~~be obtained.~~

Application No. 10/692,125
Response to Office Action

Customer No. 01933

2. (Currently Amended) A semiconductor light emitting device according to claim 1, ~~wherein the semiconductor light emitting device further comprises~~ comprising:

5 a first SCH (Separate Confinement Heterostructure) layer formed from InGaAsP, which is formed between the active layer and the n-type cladding layer; and

a second SCH layer formed from InGaAsP, which is formed between the active layer and the p-type cladding layer.

Claim 3 (Canceled).

4. (Currently Amended) A semiconductor light emitting device according to claim 1, wherein the active layer ~~includes~~ comprises a plural-layer MQW (Multi-quantum well) structure having including plural-layer well layers and plural-layer barrier layers positioned at ~~the~~ both sides of the respective well layers ~~at the plural-layer well layers~~.

5

5. (Original) A semiconductor light emitting device according to claim 2, wherein the first SCH layer includes a multilayer structure formed from a plurality of layers, and the second SCH layer includes a multilayer structure formed from a plurality of layers.

Application No. 10/692,125
Response to Office Action

Customer No. 01933

6. (Currently Amended) A semiconductor light emitting device according to claim 5, wherein, given that a refractive index of a layer having the a lowest refractive index of said plurality of layers structuring in the active layer is n_s , and
 5 given that respective refractive indices and thickness
thicknesses of said plurality of layers of the first SCH layer are respectively $n_1, n_2, n_3, \dots, n_N$ and $t_1, t_2, t_3, \dots, t_N$, an at order close increasing from the active layer, and given that
 10 respective refractive indices and thickness thicknesses of said plurality of layers of the second SCH layer are respectively $n_1, n_2, n_3, \dots, n_N$ and $t_1, t_2, t_3, \dots, t_N$, in an at order close increasing from the active layer,

~~the relationship of the thickness~~ thicknesses of the respective layers is of both the first and second SCH layers are
 15 set to be satisfy a relationship:

$$t_1 = t_2 = t_3 =, \dots, = t_N$$

~~the relationship of the magnitudes of the refractive indices of the respective layers of the active layer, the first SCH layer, the second SCH layer, the n-type cladding layer and the p-type cladding layer~~ is set to ~~be the~~ satisfy a relationship:
 20

$$n_s > n_1 > n_2 > n_3 >, \dots, n_N > n_a > n_b$$

such that the refractive indices of the first and second SCH layers become smaller ~~the further away~~ with increasing distance from the active layer, and ~~including the relationship~~

Application No. 10/692,125
Response to Office Action

Customer No. 01933

25 ~~that the refractive index n_s of the active layer is the highest,~~
~~and the refractive index n_a of the n-type cladding layer is~~
~~higher than the refractive index n_b of the p-type cladding layer,~~
and

differences between the refractive index differences between
30 the indices of adjacent layers which are adjacent to one another
in said plurality of layers respectively structuring the first
SCH layer and the second SCH layer are set to ~~be the~~ satisfy a
relationship:

$$n_s - n_1 > n_1 - n_2 > n_2 - n_3 > \dots > n_N - n_b > n_N - n_a$$

35 such that the differences between the refractive index
~~differences~~ indices become smaller ~~the further toward~~ with
decreasing distance from the corresponding one of the n-type
cladding layer and the p-type cladding layer and increasing
distance from the active layer.

7. (Currently Amended) A semiconductor light emitting
device according to claim 5, wherein, given that a refractive
index of a layer having ~~the a~~ a lowest refractive index ~~of said~~
~~plurality of layers structuring in~~ the active layer is n_s , ~~the~~
5 given that respective refractive indices and ~~the thickness~~
thicknesses of said plurality of layers of the first SCH layer
are ~~respectively~~ $n_1, n_2, n_3, \dots, n_N$ and $t_1, t_2, t_3, \dots, t_N$, an at
order ~~close~~ increasing from the active layer, and given that

Application No. 10/692,125
Response to Office Action

Customer No. 01933

10 respective refractive indices and ~~the thickness~~ thicknesses of
said plurality of layers of the second SCH layer are ~~respectively~~
n1, n2, n3, ..., nN and t1, t2, t3, ..., tN, in an ~~at~~ order close
increasing from the active layer,

15 ~~the relationship of the magnitudes of the refractive indices~~
~~of the respective layers~~ of the active layer, the first SCH
layer, the second SCH layer, the n-type cladding layer and the p-
type cladding layer is set to ~~be the~~ satisfy a relationship:

$$n_s > n_1 > n_2 > n_3 > \dots, n_N > n_a > n_b$$

20 such that the refractive indices of the first and second SCH
layers become smaller ~~the further away~~ with increasing
distance from the active layer, ~~including the relationship that~~
~~the refractive index ns of the active layer is the highest, and~~
~~the refractive index na of the n-type cladding layer is higher~~
~~than the refractive index nb of the p-type cladding layer,~~

25 differences between the refractive index ~~differences between~~
~~the indices of adjacent~~ layers which ~~are adjacent to one another~~
in said plurality of layers respectively structuring the first
SCH layer and the second SCH layer are set to ~~be the~~ satisfy a
relationship:

$$n_s - n_1 = n_1 - n_2 = n_2 - n_3 = \dots, = n_N - n_b$$

30 ~~(where $n_N - n_b > n_N - n_a$),~~ where $n_N - n_b > n_N - n_a$
~~such that the refractive index differences are equal to one~~
~~another, and~~

Application No. 10/692,125
Response to Office Action

Customer No. 01933

~~the relationship of the thickness~~ thicknesses of the
respective layers is of both the first and second SCH layers are
35 set to be satisfy a relationship:

$$t1 < t2 < t3 < \dots < tN$$

such that the ~~thickness becomes~~ thicknesses become larger the
further away with increasing distance from the active layer.

8. (Currently Amended) A semiconductor light emitting
device according to claim 5, wherein, given that a refractive
index of a layer having ~~the a~~ lowest refractive index ~~of said~~
~~plurality of layers structuring in~~ the active layer is n_s , the
5 given that respective refractive indices and ~~the thickness~~
thicknesses of said plurality of layers of the first SCH layer
are respectively $n_1, n_2, n_3, \dots, n_N$ and $t_1, t_2, t_3, \dots, t_N$, an at
order close increasing from the active layer, and given that
respective refractive indices and ~~the thickness~~ thicknesses of
10 said plurality of layers of the second SCH layer are respectively
 $n_1, n_2, n_3, \dots, n_N$ and $t_1, t_2, t_3, \dots, t_N$, in an at order close
increasing from the active layer,

~~the relationship of the~~ magnitudes of the refractive indices
of the respective layers of the active layer, the first SCH
15 layer, the second SCH layer, the n-type cladding layer and the p-
type cladding layer is set to ~~be the~~ satisfy a relationship:

$$n_s > n_1 > n_2 > n_3 > \dots > n_N > n_a > n_b$$

Application No. 10/692,125
Response to Office Action

Customer No. 01933

such that the refractive indices of the first and second SCH
layers become smaller ~~the further away with increasing~~
20 distance from the active layer, ~~including the relationship that~~
~~the refractive index n_s of the active layer is the highest, and~~
~~the refractive index n_a of the n-type cladding layer is higher~~
~~than the refractive index n_b of the p-type cladding layer,~~
differences between the refractive index ~~differences between~~
25 the indices of adjacent layers ~~which are adjacent to one another~~
in said plurality of layers respectively structuring the first
SCH layer and the second SCH layer are set to ~~be the~~ satisfy a
relationship:

$$n_s - n_1 > n_1 - n_2 > n_2 - n_3 > \dots > n_N - n_b > n_N - n_a$$

30 such that the differences between the refractive index
differences indices become smaller ~~the further away with~~
increasing distance from the active layer, and

~~the relationship of the thickness~~ thicknesses of the
respective layers ~~is of both the first and second SCH layers are~~
35 set to ~~be~~ satisfy a relationship:

$$t_1 < t_2 < t_3 < \dots < t_N$$

such that the ~~thickness becomes~~ thicknesses become larger ~~the~~
~~further away with increasing distance~~ from the active layer.

9. (Currently Amended) A semiconductor light emitting
device according to claim 5, wherein, given that a refractive

Application No. 10/692,125
Response to Office Action

Customer No. 01933

index of a layer having ~~the a~~ lowest refractive index ~~of said~~
~~plurality of layers structuring in~~ the active layer is n_s , and
 5 ~~given that respective~~ refractive indices and ~~thickness~~
~~thicknesses~~ of said plurality of layers of the first SCH layer
 are ~~respectively~~ $n_1, n_2, n_3, \dots, n_N$ and $t_1, t_2, t_3, \dots, t_N$, ~~an at~~
 order ~~close~~ increasing from the active layer, and ~~given that~~
~~respective~~ refractive indices and ~~thickness~~ thicknesses of said
 10 plurality of layers of the second SCH layer are ~~respectively~~ $n_1,$
 n_2, n_3, \dots, n_N and $t_1, t_2, t_3, \dots, t_N$, ~~in an at~~ order ~~close~~
increasing from the active layer,

~~the relationship of the thickness~~ thicknesses of the
 respective layers ~~is of both the first and second SCH layers are~~
 15 set to ~~be~~ satisfy a relationship:

$$t_1 = t_2 = t_3 =, \dots, = t_N$$

~~the relationship of the~~ magnitudes of the refractive indices
 of the respective layers of the active layer, the first SCH
layer, the second SCH layer, the n-type cladding layer and the p-
 20 type cladding layer is set to ~~be the relationship~~ satisfy
relationships:

$$n_s > n_1 > n_2 > n_3 >, \dots, n_N > n_b, \text{ and } n_a > n_N$$

such that the refractive indices of the first and second SCH
layers become smaller ~~the further away with increasing~~
 25 distance from the active layer, ~~and including the relationship~~
~~that the refractive index n_s of the active layer is the highest,~~

Application No. 10/692,125
Response to Office Action

Customer No. 01933

~~and the refractive index n_a of the n-type cladding layer is higher than the refractive index n_b of the p-type cladding layer, and~~

30 ~~the refractive index differences between the indices of adjacent layers which are adjacent to one another~~
in said plurality of layers respectively structuring the first SCH layer and the second SCH layer are set to ~~be the~~ satisfy a relationship:

35
$$n_s - n_1 > n_1 - n_2 > n_2 - n_3 > \dots > n_{(N-1)} - n_N$$

such that the differences between the refractive index
~~differences indices~~ become smaller ~~the further toward~~ with
decreasing distance from the corresponding one of the n-type
cladding layer and the p-type cladding layer and increasing
40 distance from the active layer.

10. (Currently Amended) A semiconductor light emitting device according to claim 5, wherein, given that a refractive index of a layer having ~~the a~~ a lowest refractive index ~~of said plurality of layers structuring in~~ the active layer is n_s , ~~the~~
5 given that respective refractive indices and ~~the thickness~~
thicknesses of said plurality of layers of the first SCH layer are ~~respectively~~ $n_1, n_2, n_3, \dots, n_N$ and $t_1, t_2, t_3, \dots, t_N$, an at
order ~~close~~ increasing from the active layer, and given that
respective refractive indices and ~~the thickness~~ thicknesses of

Application No. 10/692,125
Response to Office Action

Customer No. 01933

10 said plurality of layers of the second SCH layer are ~~respectively~~
n1, n2, n3, ..., nN and t1, t2, t3, ..., tN, in an ~~at~~ order ~~close~~
increasing from the active layer,

~~the relationship of the magnitudes of the refractive indices~~
of the respective layers of the active layer, the first SCH
15 layer, the second SCH layer, the n-type cladding layer and the p-
type cladding layer is set to ~~be the relationship~~ satisfy
relationships:

$$n_s > n_1 > n_2 > n_3 > \dots, n_N > n_b, \text{ and } n_a > n_N$$

such that the refractive indices of the first and second SCH
20 layers become smaller ~~the further away with increasing~~
distance from the active layer, ~~including the relationship that~~
~~the refractive index n_s of the active layer is the highest, and~~
~~the refractive index n_a of the n-type cladding layer is higher~~
~~than the refractive index n_b of the p-type cladding layer, and~~

25 differences between the refractive ~~index~~ differences between
the indices of adjacent layers ~~which are adjacent to one another~~
in said plurality of layers respectively structuring the first
SCH layer and the second SCH layer are set to ~~be the~~ satisfy a
relationship:

$$30 \quad n_s - n_1 = n_1 - n_2 = n_2 - n_3 = \dots = n_N - n_b$$

~~such that the refractive index differences are equal to one~~
another, and

Application No. 10/692,125
Response to Office Action

Customer No. 01933

~~the relationship of the thickness~~ thicknesses of the
respective layers ~~is of both the first and second SCH layers are~~
35 set to ~~be~~ satisfy a relationship:

$$t_1 < t_2 < t_3 < \dots < t_N$$

such that the ~~thickness becomes~~ thicknesses become larger the
further ~~away with increasing distance~~ from the active layer.

11. (Currently Amended) A semiconductor light emitting
device according to claim 5, wherein, given that a refractive
index of a layer having ~~the a~~ lowest refractive index ~~of said~~
~~plurality of layers structuring in~~ the active layer is n_s , ~~the~~
5 given that respective refractive indices and ~~the thickness~~
thicknesses of said plurality of layers of the first SCH layer
are respectively $n_1, n_2, n_3, \dots, n_N$ and $t_1, t_2, t_3, \dots, t_N$, an at
order ~~close~~ increasing from the active layer, and given that
respective refractive indices and ~~the thickness~~ thicknesses of
10 said plurality of layers of the second SCH layer are respectively
 $n_1, n_2, n_3, \dots, n_N$ and $t_1, t_2, t_3, \dots, t_N$, in an at order ~~close~~
increasing from the active layer,

~~the relationship of the~~ magnitudes of the refractive indices
of the respective layers of the active layer, the first SCH
15 layer, the second SCH layer, the n-type cladding layer and the p-
type cladding layer is set to ~~be the relationship~~ satisfy
relationships:

Application No. 10/692,125
Response to Office Action

Customer No. 01933

$$n_s > n_1 > n_2 > n_3 > \dots, n_N > n_b, \text{ and } n_a > n_N$$

such that the refractive indices of the first and second SCH
20 layers become smaller ~~the further away with increasing~~
distance from the active layer, ~~including the relationship that~~
~~the refractive index n_s of the active layer is the highest, and~~
~~the refractive index n_a of the n-type cladding layer is higher~~
~~than the refractive index n_b of the p-type cladding layer, and~~

25 differences between the refractive index ~~differences between~~
~~the indices of adjacent layers which are adjacent to one another~~
in said plurality of layers respectively structuring the first
SCH layer and the second SCH layer are set to ~~be the~~ satisfy a
relationship:

$$n_s - n_1 > n_1 - n_2 > n_2 - n_3 > \dots, > n_{(N-1)} - n_N$$

30 such that the differences between the refractive index
~~differences indices~~ become smaller ~~the further away with~~
increasing distance from the active layer, and

~~the relationship of the thickness~~ thicknesses of the
35 respective layers is of both the first and second SCH layers are
set to ~~be~~ satisfy a relationship:

$$t_1 < t_2 < t_3 < \dots, < t_N$$

such that the ~~thickness becomes~~ thicknesses become larger the
~~further away with increasing distance~~ from the active layer.

Application No. 10/692,125
Response to Office Action

Customer No. 01933

12. (Original) A semiconductor light emitting device according to claim 2, wherein the semiconductor light emitting device is formed so as to be a buried structure.

13. (Currently Amended) A semiconductor light emitting device according to claim 12, wherein the n-type cladding layer, the first SCH layer, the active layer, the second SCH layer, and a part of the p-type cladding layer are formed to be a mesa type, and the semiconductor light emitting device further comprises:

a first buried layer formed from p-type InP such that one surface thereof contacts one of the semiconductor substrate ~~or~~ and the n-type cladding layer at ~~the~~ both sides of the respective layers formed to be a mesa type; and

a second buried layer formed from n-type InP such that one surface thereof contacts the p-type cladding layer and the other surface thereof contacts the other surface of the first buried layer at ~~the~~ said both sides of the respective layers formed to be a mesa type.

14. (Original) A semiconductor light emitting device according to claim 1, wherein the semiconductor light emitting device is formed so as to be a ridge structure.

Application No. 10/692,125
Response to Office Action

Customer No. 01933

15. (Currently Amended) A semiconductor light emitting device according to claim 14, wherein, when the semiconductor substrate is n-type, the p-type cladding layer ~~is formed as~~ comprises a ridge structured portion in which ~~the~~ a substantially central portion ~~at the of an~~ of an outer side thereof ~~is heaped to the upper side~~ extends outward farther than outer portions thereof, and the semiconductor light emitting device further comprises:

a contact layer formed at ~~the~~ an upper side of the ridge structured portion at the p-type cladding layer;

an insulating layer formed so as to ~~open the~~ expose a central portion of the contact layer, and so as to cover the p-type cladding layer including the ridge structured portion; and

an electrode formed at ~~the~~ a top portion of the insulating layer ~~in a state in which~~ such that one portion thereof is connected to the contact layer.

16. (Currently Amended) A semiconductor light emitting device according to claim 1, wherein a bandgap wavelength of InGaAsP structuring the n-type cladding layer is ~~less~~ not more than ~~or equal to~~ 0.97 μm .

Claims 17 and 18 (Canceled).

Application No. 10/692,125
Response to Office Action

Customer No. 01933

19. (Currently Amended) A semiconductor light emitting device according to claim 1, wherein, when the semiconductor substrate is n-type, the n-type cladding layer is formed at ~~the~~ a lower side of the active layer, and the p-type cladding layer is formed at ~~the~~ an upper side of the active layer.

20. (Currently Amended) A semiconductor light emitting device according to claim 1, wherein, when the semiconductor substrate is p-type, the n-type cladding layer is formed at ~~the~~ an upper side of the active layer, and the p-type cladding layer is formed at ~~the~~ a lower side of the active layer.